

Comparison of the Effect of Milk and Pistachio Snacks on Anthropometric Indices in Overweight or Obese Women: A Randomized Crossover Trial

Abstract

Background: Weight management is the key to prevent and treat the adverse consequences of overweight and obesity. The aim of this study was to compare the effect of consuming milk and pistachio snacks on anthropometric indices in overweight or obese women. **Methods:** In this randomized crossover trial, 60 overweight or obese women with a mean age of 24 ± 4.2 years were randomly divided into two groups. Women in the milk group received 200 mL/day low-fat milk while women in the other group received 30 g/day pistachio for 4 weeks. After a 6-day washout period, the participants received a similar intervention in a crossover manner. **Results:** Out of the total 60 participants, 52 completed the study. At the end of the study, the weight of women in the milk group significantly decreased (70.8 ± 8.4 vs. 69.9 ± 8.3 , P value = 0.001). No statistically significant changes were observed in the weight of participants in the pistachio group (70.3 ± 8.4 vs. 70.6 ± 8.3 , P value = 0.06). Further analyses showed a slightly significant beneficial effect on waist circumference (WC) (P -value = 0.068) and body mass index (BMI) in the milk group P value = 0.01). **Conclusions:** Based on the observed positive effects of milk intake on weight loss in this crossover study, milk consumption may be considered an appropriate snack in weight loss programs in overweight or obese women.

Keywords: Anthropometric indices, crossover, milk, obesity, overweight, pistachio

Introduction

In recent decades, obesity has become globally widespread and considered as the most serious and prevalent noncommunicable disease,^[1] and its prevalence is rapidly increasing in Iran.^[2,3] In 2015, 107.7 million children and 603.7 million adults were identified to have obesity.^[1] Obesity and overweight are associated with many chronic diseases.^[4] In fact, obesity has a multifactorial nature resulting from genetic, epigenetic, physiological, behavioral, sociocultural, and environmental factors. The main reason for obesity is the surplus of energy intake compared to energy expenditure.^[5] In recent decades, many efforts have been made to prevent and control obesity and overweight.^[6] The cornerstones of obesity management are dietary modifications, physical activities, lifestyle changes, and pharmacotherapy.^[7] A wide spectrum of weight-loss diets as the golden key to obesity treatment has been developed in recent years.^[8] The high-friction ratio in weight loss programs is most common.^[9] In

general, overweight and obese people are not successful in losing and maintaining their weight in the long-term.^[10,11] Various studies indicate that 30–60% of participants fail the weight loss program.^[12] Numerous determinants of food intake patterns and consequent weight gain have been described in the literature.^[13,14] Success in weight loss is closely related to controlling food intake.^[14] Snacking can increase the chance for healthy and low-calorie food choices, resulting in a diversity of foods in the diet and a balanced intake of nutrients contributing remarkably to daily energy intake.^[15] Intake of an appropriate and healthy snack may, therefore, be one of the regulators of energy.^[15,16] High-protein and low-calorie snacks reduce subsequent food intake compared to other commonly consumed snacks, especially high-energy snacks.^[17] Protein is the most potent nutrient compared to other macronutrients for increasing satiety in isoenergetic conditions.^[18] However, existing evidence regarding the amount and type of effective food protein in weight loss is contradictory.^[19,20] Therefore, the aim of the present study was to assess and compare

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the effects of milk and pistachio snack consumption on anthropometric indices in overweight or obese women.

Methods

Subject and setting

A randomized crossover study was carried out on 60 overweight or obese female students. They were dissatisfied with their weight and body image but overall, they did not have any recognized medical condition. This trial was completed in 2 months separated by a 6-day wash-out period.^[21] Participants were university students living at the dormitories in Ahvaz Jundishapur University of Medical Sciences, who were selected by convenience sampling method. The reason for choosing samples from dormitories was that they almost have similar lifestyles, and especially a similar food pattern. Psychological status, physical activity, mental, and nutritional status (as a few baseline characteristics) were assessed by DASS 21 questionnaire (Depression Anxiety Stress Scales),^[22] IPAQ (International Physical Activity Questionnaire)^[23] and food records (two working days and one weekend day),^[21] respectively at the beginning and at the end of each phase of intervention. Dietary data were analyzed by popular software (Nutritionist IV, version 3.2) $n = 26$ [Figure 1]. The Research Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (IR.AJUMS.REC.1397.529) approved the present study. Registration ID in IRCT (*IRCT20181024041448N1*).

After obtaining consent, advertisements were offered in the female dormitory of the university. On the screening day, based on the initial eligibility criteria, people were invited to the research center. Later, the researcher gave a general explanation to the students. The inclusion criteria for this study were as follows body mass index (BMI) above 24.99 kg/m², aged 18–50 years, no specific therapeutic diet, willing to lose weight, and absence of any history of illness. Participants were excluded, if they were smokers, being a professional athlete, lack of sensitivity to the study snacks, history of food allergies, and intake of medication or supplements. Around 60 overweight or obese female students were finally selected. Informed written consent was provided by all participants. They were randomly allocated into two groups using a random list. The order of intervention in each group was as follows: Group A: consuming 200 mL/day low-fat milk (1.5%) for 4 weeks, followed by a 6-day washout period, and then consuming 30 g/day raw pistachios for 4 weeks. Group B: consuming 30 g/daily raw pistachios for 4 weeks, followed by a 6-day washout period, and then consuming 200 mL/daily low-fat milk (1.5%) for 4 weeks. The weight of pistachio was measured using a calibrated digital scale, and they were placed in appropriate packages. Since pistachio is one of the common nuts and functional food in Iran,^[24] and due to the high acceptance of milk as a snack, we chose these foods as snacks.^[21] According to food composition tables, the amount of milk and pistachio was chosen to provide close energy content, i.e., almost 100 Kcal.^[25]

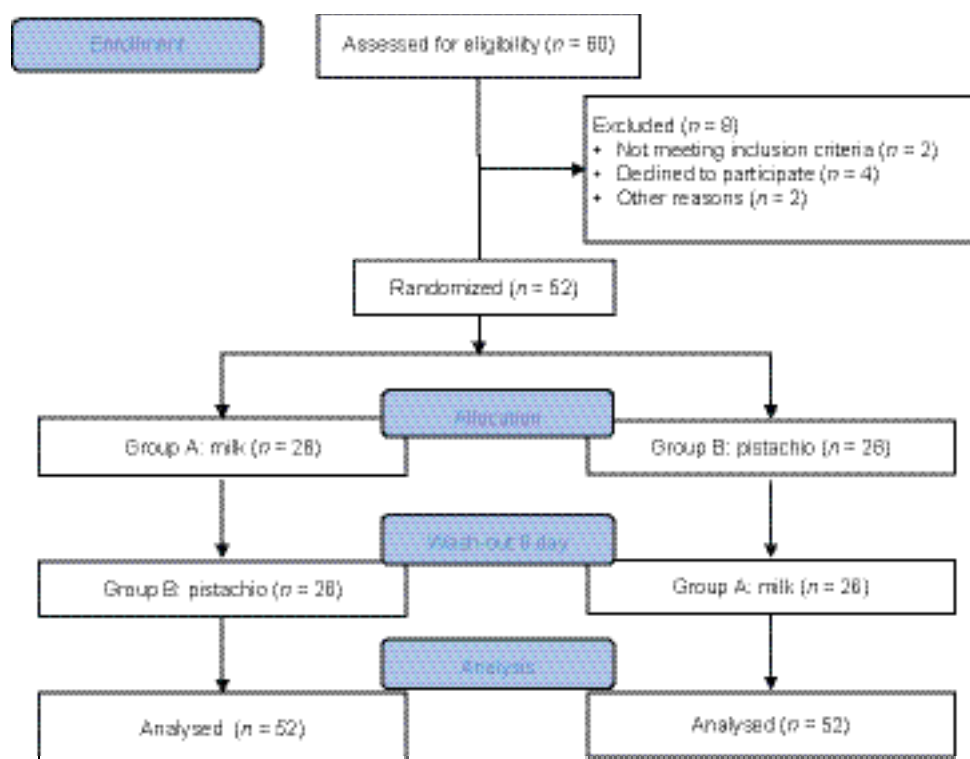


Figure 1: Study design: visits and examinations during the intervention

Protocol

The participants were asked to have milk or pistachio as a morning-snack between 10 and 10:30 am each day during the intervention. Participants were asked to continue their routine life without any change in their diet. During a 6-day run-in period, the participants were evaluated to determine eligibility criteria, and their ability and willingness to continue with the study. Each intervention period lasted 4 weeks and was separated by a 6-day wash-out period. After the wash-out period, the interventions were exchanged. A daily mobile phone message was sent to remind the participants of consuming their snacks. In addition, a WhatsApp group was created for providing general information.

Anthropometric measurement

Anthropometric measurements were carried out at the beginning and at the end of each intervention stage. Weight was measured by using a calibrated digital weight scale (Digital Scales GLAMOR GBF-830, China) with light clothes and barefoot. The height of the participants was measured while standing straight and looking forward barefoot using a height gauge with 0.1 cm resolution. For calculating the waist circumference (WC), participants were made to stand straight and one of the narrowest areas of the lower lateral limb and the crystal elliptic were measured.^[26] Hip measurement was considered as the largest circumference of the buttocks. BMI was calculated by weight (kg) divided by height (m²).^[26] To calculate the

waist to hip ratio (WHR), waist circumference was divided by hip circumference.^[26]

Statistical analyses

Results were expressed as means \pm standard deviation (SD). The analyses were conducted using SPSS version 22. The demographic data and subject characteristics were analyzed using an independent *t*-test for independent samples. Within-subject changes were analyzed by the paired-sample *t*-test. Between the subject group, differences were calculated by the independent samples *t*-test. A *P* value of less than 0.05 was considered statistically significant.

Results

Sixty overweight or obese healthy women aged between 24.42 ± 4.2 years were recruited of whom 52 completed the study. Reasons for dropping out included religious fasting ($n = 2$), illness ($n = 4$), or personal reasons ($n = 2$). There were no statistically significant differences in the baseline values between the two groups. Participation in both groups had not any significant differences in their physical activity, mood condition, and calorie intake [Table 1]. Our results showed that females in the milk consumption group had a significant reduction in body weight ($P = 0.001$). Females in the pistachio consumption group, instead, experienced no statistically significant change in their body weight. Both snacks had a positive effect on WC reduction ($P < .05$) but no statistically significant change was observed in WHR because of a significant decrease in hip circumference. Omitting pistachio snack, milk snack could reduce BMI [Table 2]. Between-group analysis indicated that participants in the milk group experienced decreased BMI compared with those in the pistachio group ($P = 0.001$). Milk snack, as opposed to pistachio snack, could reduce waist circumference ($P = 0.001$). Moreover, for hip circumference, there was a statistically significant difference between snacks ($P = 0.014$). WHR was not significantly different between groups ($P = 0.212$) [Table 3].

Discussion

According to our results, consumption of milk and pistachio as a snack had different biological influences on anthropometric indices; however, this difference was not statistically significant. Although there is no agreement

Table 1: Baseline characteristics of participants

	Milk (Mean \pm SD)	Pistachio (Mean \pm SD)	<i>P</i>
Age (year)	24.46 \pm 3.27	25.35 \pm 5.07	0.923
Weight (kg)	70.50 \pm 8.79	70.77 \pm 8.22	0.996
WC [†] (cm)	86.68 \pm 6.99	87.58 \pm 7.14	0.413
HC [‡] (cm)	105.67 \pm 6.76	104.77 \pm 6.13	0.707
WHR [§] (cm)	0.82 \pm 0.06	0.83 \pm 0.04	0.645
BMI (kg/m ²)	27.81 \pm 2.62	27.97 \pm 2.98	0.864
Depression	8.92 \pm 2.13	8.00 \pm 2.07	
Mood anxiety	7.73 \pm 1.88	7.38 \pm 2.31	0.999
Stress	9.76 \pm 2.95	9.76 \pm 3.17	
PAL (met-minute/week)	1302.84 \pm 407.18	1302.84 \pm 407.18	0.999
Energy (Kcal)	2742.57 \pm 128.33	2592.41 \pm 142.55	0.488

*Independent *t*-test. [†]Waist circumference. [‡]Hip circumference.

[§]Waist to hip ratio. ^{||}Body Mass Index. [¶]Physical Activity Level

Table 2: Within groups anthropometric indices of participants before and after the intervention

Variables	Milk		<i>P</i> [*]	Pistachio		<i>P</i> [*]
	Before	After		Before	After	
Weight (kg)	70.77 \pm 8.36	69.87 \pm 8.30	0.001	70.34 \pm 8.36	70.60 \pm 8.29	0.058
WC [†] (cm)	78.62 \pm 11.00	76.64 \pm 10.93	0.001	79.04 \pm 11.71	78.36 \pm 12.52	0.001
HC [‡] (cm)	99.33 \pm 10.04	97.67 \pm 9.32	0.001	98.28 \pm 8.78	97.55 \pm 9.21	0.001
WHR [§] (cm)	0.79 \pm 0.060	0.78 \pm 0.062	0.068	0.80 \pm 0.06	0.79 \pm 0.07	0.437
BMI (kg/m ²)	27.95 \pm 2.75	27.59 \pm 2.72	0.01	27.66 \pm 2.72	27.76 \pm 2.67	0.18

*Paired *t*-test, [†]Waist circumference, [‡]Hip circumference, [§]Waist to hip ratio, ^{||}Body Mass Index

Table 3: Between groups anthropometric indices of participants before and after the intervention

Variables	Milk	Pistachio	P*
Weight (kg)	-0.89±0.17	0.25±0.32	0.001
WC [†] (cm)	-1.98±2.45	-0.68±1.40	0.001
HC [‡] (cm)	-1.65±2.19	-0.73±1.52	0.014
WHR [§] (cm)	-0.00±0.02	-0.00±0.015	0.212
BMI (kg/m ²)	-0.35±0.07	0.09±0.13	0.001

*Independent *t*-test. [†]Waist circumference, [‡]Hip circumference,

[§]Waist to hip ratio, ^{||}Body Mass Index

on the effect of snacking and weight management,^[27] choosing healthy foods for snacks can prove beneficial in either weight loss or weight control.^[28] According to Kong *et al.*, snacking has a positive impact on weight loss.^[29]

Our results suggested that milk consumption as a snack has significant positive effects on weight loss. Several studies were conducted earlier on the direct relationship between dairy intake and obesity prevention.^[30-33] The positive effects of dairy products on weight loss^[34,35] can be considered as the most important mechanism in the treatment and prevention of obesity. Several mechanisms to evaluate the effect of dairy products on body weight and composition have been suggested. These mechanisms include dairy's calcium component, medium-chain fatty acids, and unique proteins appetite regulation that can play a prominent role.^[36] The primary evidence for the inverse association between dairy consumption and obesity originated from a few cross-sectional and meta-analysis studies attributed to an inverse relationship of dairy intake (from all dairy sources) with bodyweight to calcium content.^[37] Anderson *et al.* reported that milk is beneficial for maintaining body weight. They proposed that unique proteins in milk with their specific physiological functions help maintain healthy body weight.^[38] Gilbertan *et al.* reported the positive effect of milk supplementation on the anorexigenic signal and subsequent body weight loss.^[33] Recently, the focus of studies on the effect of dairy on appetite regulation has been particularly increasing.^[21,39] Other mechanisms mentioned for weight control by dairy products were related to increased satiety and reduced hunger.^[40] Our study also demonstrated that the consumption of milk as a snack would result in WC reduction, which was consistent with studies by Abargouei *et al.*^[36]

From the quantitative point of view, beneficial anthropometric effects of milk snacks in this study may seem inconsiderable. Nevertheless, two points to be noted were: firstly, the duration of this intervention was not long. If milk snack consumption enters the usual food habits, it may make stronger effects in longer times. Secondly, participants in this study were not under formal weight loss programs. As mentioned previously, they just were unhappy with their body weight but were not ready to perform serious low-calorie diets. It is possible that adding

milk snack to weight loss diets decrease the weight to higher amounts.

Obese and overweight individuals may not consume healthy snack nuts because of concern about weight gain as a consequence of eating nuts such as pistachio.^[41] In this paper, pistachio consumption led to weight gain that was not statistically significant^[42] but this was not confirmed by previous studies. Both Wang's and Li's studies show that consumption of pistachios did not lead to weight gain.^[43,44] Many mechanisms have been proposed to elucidate an inverse relationship between nut intake and weight gain. Coates and Howe suggested that nut consumption can promote appetite signal and energy balance, positively influence lipids profile, and increase fat absorption.^[45] The weight control mechanism by pistachios may be attributed to its specific ingredients. Quercetin and catechin in pistachio can change glucose absorption from the gut and intestinal α -glucosidase and pancreatic enzyme.^[46] Pistachio's phytosterol component can decrease cholesterol absorption from the gut.^[47] This controversy may be due to the differences in the amount and duration of pistachios consumed as snacks. In one study, nuts were compared to other energy-dense snacks, and it was reported that nuts did not have any negative impact on body weight or lipid value^[48] Similar to Wilson's study, our results concerning BMI differences between after-intervention and before-intervention were not affected by pistachio consumption.^[42]

This study has a few strengths. The selected snacks were among the most common ones, which can be eaten by most people as habitual behavior. To the best knowledge of authors, it is the first study on comparing milk and pistachio snacks for weight loss by a cross over design. Almost all potential confounding factors may be adjusted by this type of research. Participants of this study were not happy with their weight but were not ready to follow formal weight-loss diets. Many such persons exist in all communities. Even a small effect on the weight of these persons can make large beneficial effects from the public health point of view. A short time of this study was a limitation. Another limitation was no estimation of consumed foods during hours after snack intake, and particularly, the energy content of lunch meal. These limitations need to be considered for future studies.

Conclusion

Obese and overweight people generally had negative perceptions of all kinds of snacks. Therefore, this may lead them to avoid eating snacks. However, pistachio can be a good instance of a snack as opposed to other harmful snacks without exerting a very large effect on weight gain. Furthermore, milk can be a good snack for weight loss as a mid-morning snack.

We suggest that future researches also consider the participants' cognition of test snacks.

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Declaration of patient consent

In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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